and studied by the writer with the assistance of Dr. M. A. Howe and Dr. A. W. Evans, *Cephalozia Francisci* (Hook.) Dumort. is recognized for the first time as an American species. *Cephalozia Francisci* is somewhat rare in Europe, though it has been found in England, Ireland, France, Denmark and Germany. Various botanists have mentioned and described it, Sir W. J. Hooker being the original describer under the name of *Jungermannia Francisci* in his British Jungermanniae, *pl. 49*. His full description and figures agree with our specimen except in regard to the perianth, which he says is "evidently toothed," ours being simply repand as Spruce later described it in his work on *Cephalozia* (p. 49). The perianths in our specimen agree well with those of two specimens from the Rheinprovinz in the herbarium of the New York Botanical Garden. In Europe the species is said to be "in fruit," gemmiparous also, in spring and early summer; here, at this Maine station, it bears gemmae, immature androecia, and perianths with immature sporogonia, in August. This locality in Maine proved also a new station for *Frullania Tamarisci* (L.) Dumort., which is rare in this country; and *Scapania curta* (Mart.) Dumort., also, was found growing there with *Riccardia latifrons* Lindb. and *Cephalozia lunulaefolia* Dumort., evincing the same choice of associates as when found a few years ago on the other side of the continent, at Sisson, Siskiyou Co., California, by Dr. Howe.

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REVIEWS

The Influence of Light and Darkness upon Growth and Development.*

So incomplete and contradictory conclusions have been obtained upon this subject by various authors since the time of John Ray, 1686, that it is fortunate that this question has been at last taken up in a systematic and comprehensive manner. In the present memoir, Doctor MacDougal has presented an exceptionally important contribution to science. The work is a model of its kind not only in the scope of the undertaking, but in the

* MacDougal, D. T. The Influence of Light and Darkness upon Growth and Development. Mem. N. Y. Bot. Garden **2**: i–xiii + 1–319. *f. 1–176*. 20 Ja. 1903.

manner and form of presentation. A review of the more important investigations and conclusions that have been reached by various authors prefaces the observations. During the seven years in which the work was prosecuted, ninety-seven species of plants were cultivated in continuous darkness with controls in ordinary alternation of daylight and darkness. Plants illustrating a wide range of habit and habitat were utilized, embracing aquatics, creepers, climbers, succulents, mycorhizal forms and fungi, geophilous and aërial shoots, mesophytes and xerophytes. These were grown from tubers, corms, rhizomes, cuttings of leaves and stems, seeds and spores. A full account of the conditions of experimentation and results obtained with each of these plants is given, together with 176 cuts illustrating the morphological and histological variations. The concluding portion of the volume is devoted to a general consideration and interpretation of the results obtained, and deals with the effect of light and darkness upon the various organs and tissues, the nature of etiolation, the relation of light and darkness to growth and differentiation, the stimulative influence of light, and the influence of etiolation upon chemical composition. An excellent index enhances the value of the book.

Of the many important features that should be mentioned the limits of this review permit the presentation of only a few. A wide variation is to be seen in the amount of growth or increase in volume, and in the differentiation of the tissues and organs of the etiolated plant. It is interesting to note that in many species the total length, diameter and volume of the etiolated shoot and its organs are not so great as in the case of the plant grown under normal conditions. So also in regard to the differentiation of the tissues, no generalizations can be made owing to the diversified conditions found. In a general way it can be said that the degree of differentiation of the tissues is less marked in etiolated forms, and that primary and embryonic tissues, especially parenchyma, are subject to continued cell formation and growth. To these tissues more especially is the growth and increase in volume due. The abnormal development of this fundamental tissue doubtless also accounts for the commonly observed torsion

and twisting of etiolated parts, since the activity of these cells results in a displacement of the mechanical tissues.

Perhaps the most important result reached by the author is the demonstration of the absence of a paratonic action of light on growth. The failure of a large proportion of the plants to manifest an increased growth in darkness can only be interpreted as demonstrating that there is no invariable relation existing between light and increase in length and thickness or between the division and increase in volume of the cell. On the other hand those forms exhibiting a marked acceleration in growth when removed from the light show adaptional elongations that can be explained by the stimulative action of darkness rather than by the retarding action of light. The views of Sachs on this subject and on the morphological significance of climbing plants and in fact the entire views of his school on the relation of light and darkness to growth and development fall to the ground as a result of the evidence here brought forward. Several other widely accepted views become untenable in the light of these extended and accurately performed experiments. The attempt by Kraus to explain the atrophy or meager development of leaves on the basis of a lack of nutrition is seen to be futile when wider observations reveal the fact that often the development in darkness may equal or exceed the normal growth. So also the belief, generally accepted since the time of Boehm and Godlewsky, that the elongations manifested in etiolated plants are adaptive reactions to lift the photosynthetic parts into the light is overthrown by the results that were obtained in many instances where these organs either failed to show any response that could possibly be interpreted as adaptive or on the other hand were clearly the reverse of beneficial. The main conclusions of the author may be summed up in these words: Darkness deprives the plant of the determinative and morphogenic influence of light and consequently the embryonic tissues are chiefly developed while the secondary tissues that appear in the plant body, in the formation of the flower, maturation of the fruit, etc., are poorly differentiated. The growth, consequently, of the etiolated plant is due to the stimulus of darkness and entirely controlled by its autotropic and geotropic reflexes. CARLTON C. CURTIS.